REMARKS

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention. Specifically, Applicants have amended claim 1 to recite that the vaporizer includes a co-axial nozzle, wherein an outside diameter of the nozzle "tapers" toward its outlet to the vaporization chamber; claim 1 has been further amended to recite that the co-axial nozzle has a function of ejecting the CVD material to the vaporization chamber from a central nozzle thereof and a function of ejecting a carrier gas to the vaporization chamber from an outside nozzle thereof, with the central nozzle extending toward the vaporization chamber with a length of 0.2-1.0 mm beyond the end of the outside nozzle opening into the vaporization chamber. See, e.g., Figs. 4(1)-(4) and 5(1)-(4), and the corresponding description on pages 12-14 of Applicants' specification. In light of amendments to claim 1, claims 5-7 have been canceled without prejudice or disclaimer. In addition, the claims have been amended to recite the "tapering portion" of the outside diameter of the nozzle. Moreover, claims 8-10 have been amended to recite that the outside of the CVD material feed portion is composed of a metal; and claim 11 has been amended to recite cooling means "for cooling" the CVD material feed portion.

In addition, Applicants are adding new claims 13 and 14 to the application. Claim 13, dependent on claim 1, further defines the co-axial nozzle, as being provided by inner and outer tubes having a common axis, the central nozzle being provided inside the inner tube and the outside nozzle being provided between the tubes. Claim 14, dependent on claim 13, recites that the tubes are cylindrical tubes.

Applicants respectfully submit that the claims as presently amended satisfy the requirements of the second paragraph of 35 U.S.C. 112; and, in particular, are not indefinite. Thus, claim 1 has been amended to recite a co-axial nozzle, and to recite "an" outside diameter of the nozzle. The phrases "the outer diameter", "the outer tube" and "the ejection port" have been deleted from claim 1; accordingly, these bases for the rejection of claim 1 under the second paragraph of 35 U.S.C. 112, are moot. Moreover, Applicants have amended claim 1 to recite that the outside diameter of the nozzle "tapers" towards its outlet to the vaporization chamber, deleting the phrase "gradually thinning". Note that the Examiner has indicated that it is more accurate to describe the invention "in terms of a tapered or beveled surface".

Applicants have amended claim 2 to recite the preferred tapering, as described in the paragraph bridging pages 12 and 13 of Applicants' specification. In view thereof, any question as to clarity of the phrase "0 to 60°" is moot. Claims 5-7 have been canceled without prejudice or disclaimer; and, accordingly, any question as to clarity of phrases therein is moot. Furthermore, the recitation of a "contact area" in claims 8-10 is moot, in view of deletion of the phrase "contact area". Particularly in view of the description in Applicants' disclosure in connection with material of various portions of the nozzle, e.g., on page 14 of Applicants' original disclosure, and in light of claims 8-10 as presently amended, it is respectfully submitted that these claims are clear as to the areas of the structure made of metal. Applicants have amended claim 11 to recite cooling means for cooling the CVD material feed portions; accordingly, it is respectfully submitted that the basis for rejection of claim 11 under the second paragraph of 35

U.S.C. 112, as set forth in the last three lines on page 2 of the Office Action mailed December 16, 2004, is moot.

As can be seen in the foregoing, Applicants have extensively amended their claims in order to address issues raised by the Examiner under 35 U.S.C. 112, second paragraph, and to overcome these issues raised by the Examiner. If the Examiner is of the opinion that any issues remain under the second paragraph of 35 U.S.C. 112, the Examiner is respectfully requested to contact the undersigned, so as to work out agreeable language for overcoming any remaining issues. The Examiner is thanked in advance for cooperating with this request.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the prior art applied by the Examiner in rejecting the claims in the Office Action mailed December 16, 2004, that is, the teachings of U.S. Patent No. 6,245,150 to Lyons, et al., U.S. Patent No. 5,653,813 to Benzing, et al., U.S. Patent No. 6,039,808 to Toyoda, et al., and U.S. Patent No. 5,835,678 to Li, et al., and Japanese Patent Document No. 09-143738 (Onabe, et al.) under the provisions of 35 U.S.C. 102 and 35 U.S.C. 103.

It is respectfully submitted that the references relied on by the Examiner would have neither taught nor would have suggested such a vaporizer as in the present claims, including a vaporization chamber for a CVD material and a CVD material feed portion for supplying the vaporization chamber with the CVD material, and wherein the structure further includes a co-axial nozzle, wherein an outside diameter of the co-axial nozzle tapers toward its outlet to the vaporization chamber; wherein the co-axial nozzle

has functions of ejecting CVD material from a central nozzle and ejecting a carrier gas from an outside nozzle of the co-axial nozzle; and wherein the central nozzle extends toward the vaporization chamber with a length of 0.2 to 1.0 mm beyond the end of the outside nozzle opening into the vaporization chamber. See claim 1.

In addition, it is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such vaporizer as in the present claims, having features as discussed previously in connection with claim 1, and, moreover, wherein an angle of the tapering portion to a vertical line is 15-45° (see claim 2); and/or wherein curved lines through both starting and finishing ends of the tapering portion of the outside diameter of the co-axial nozzle is convex to the outside (see claim 3) or is concave to the inside (see claim 4) in a vertical cross-sectional view; and/or wherein various parts of the CVD material feed portion is composed of synthesized resin and/or of a metal as in, variously, claim 8-10; and/or wherein the apparatus further includes a cooling means for cooling the CVD material feed portion (see claim 11); and/or wherein the CVD materials are obtained by dissolving CVD materials into an organic solvent (see claim 12); and/or wherein the co-axial nozzle having the inner and outer nozzles is provided by inner and outer tubes having a common axis, the central and outside nozzles being defined relative to the inner and outer tubes (see claim 13), especially where the inner and outer tubes are each cylindrical tubes having a common axis (claim 14).

The present invention is directed to a vaporizer for supplying a chemical vapor deposition (CVD) apparatus with a gaseous CVD-material; in particular, a vaporizer

employed for vaporizing and supplying a liquid CVD-material or a CVD-material made by dissolving a solid CVD-material in a solvent, to, e.g., semiconductor manufacturing apparatus.

Recently, various dielectric films having a high dielectric constant and also a high step coverage have been used as an oxide-based dielectric film for a semiconductor memory, formed by chemical vapor deposition using various liquid and solid CVD-materials. However, in using previously proposed apparatuses, it is difficult to vaporize a liquid material at a desirable concentration and flow rate and at a high efficiency, without deteriorating the quality thereof, since the liquid materials usually have a low vapor pressure, a high viscosity and a vaporizing temperature close to a decomposing temperature. In addition, when using a solid starting material, it is extremely difficult to assure sufficient amount is supplied, in an industrial scale; moreover, since a solid material has a vaporizing temperature greatly different from that of a solvent, a solvent alone is more apt to vaporize by heating, thereby making it more difficult to vaporize a liquid material. Note the first full paragraph on page 2 of Applicants' specification.

As to various previously proposed vaporizers, attention is respectfully directed to the discussion on pages 3 and 4 of Applicants' specification. Such vaporizers have various problems. For example, stable vaporization and supply have been problems in using, e.g., solid CVD material, because the solid CVD material separated from solution and adhered in the neighborhood of the nozzle outlet to the vaporization chamber for the CVD-material, thereby causing a pressure fluctuation of vaporized gas or concentration fluctuation of the CVD-material.

Against this background, Applicants provide a vaporizer capable of vaporizing and supplying CVD-material with high vaporizing efficiency and with good stability for long periods of time, with a desired concentration and desired flow amount. Applicants have found that by use of a nozzle (for supplying CVD-material to the vaporization chamber) that is a co-axial nozzle, wherein the CVD-material is supplied to the vaporization chamber from a central nozzle of the co-axial nozzle and a carrier gas is introduced to the vaporization chamber from an outside nozzle thereof, the co-axial nozzle having an outside diameter that tapers towards its outlet to the vaporization chamber, and wherein the central nozzle extends toward the vaporization chamber with a length of 0.2-1.0 mm beyond the end of the outside nozzle opening into the vaporization chamber, such objectives of high vaporizing efficiency and stable operation for a long time, providing vaporized gas with a desired concentration and desired flow amount, are achieved.

In particular, by use of the tapered portion of the outside diameter of the co-axial nozzle, especially having an angle of taper of 15-45°, adhesion of, e.g., solid CVD-material in the neighborhood of the outlet of the nozzle into the vaporization chamber can be avoided.

Moreover, as seen in the results shown in Table 1 on page 29 of Applicants' specification, separation and adhesion of solid CVD-material near the introduction from the nozzle to the vaporization chamber is suppressed; and, accordingly, a pressure fluctuation of the vaporized gas or a concentration fluctuation of CVD-material is suppressed, with vaporizing and supplying of the CVD-material occurring with extremely

high vaporizing efficiency and operational stability for a long period of time.

Lyons, et al., discloses an apparatus and method for generating and condensing a vapor onto a substrate to form a coating, in which the vapor is generated from an atomized mist including the materials to be coated. With respect to the coating apparatus, note the paragraph bridging columns 3 and 4 of this patent. This apparatus includes an inlet end through which the fluid composition and the carrier gas enter the chamber; atomization means positioned proximal to the inlet end for generating a mist of the fluid composition in the chamber; and a support substrate provided having a chilled surface to support a substrate to be coated. See also column 2, lines 15-26 and 57-60. This patent goes on to disclose that a wide variety of nozzle structures previously known for use in generating colliding streams for other applications can be used to generate streams 22 and 20 (note Fig. 1). See column 5, lines 48-59. Note column 18, line 61 to column 20, line 38.

It is respectfully submitted that Lyons, et al. is concerned with vapor coating apparatus, not CVD apparatus, and utilizes stream collision to achieve atomization. It is respectfully submitted that this reference does not disclose, nor would have suggested, and in fact would have taught away from, the co-axial nozzle as in the present claims, especially the tapering of the outside diameter of the nozzle, and/or protrusion of the central nozzle relative to the outside nozzle, and advantages thereof in connection with CVD apparatus, as in the present invention.

The contention by the Examiner that Lyons, et al. discloses an outer surface of an outer tube having a surface that tapers in a direction toward an outlet end of the

ejection tube, without citing a specific portion of this reference having such taper, is noted. This interpretation by the Examiner of the teachings of Lyons, et al. is respectfully traversed. The Examiner is respectfully requested to point out the specific portion of Lyons, et al. showing such taper.

As seen, for example, in Figs. 5(1)-(4) of the present disclosure, the outside diameter of the co-axial nozzle tapers towards its outlet to the vaporization chamber. It is respectfully submitted that this structure would have neither been taught nor would have been suggested by the teachings of Lyons, et al. Note that in Lyons, et al., the carrier gas is ejected as a conically shaped, hollow stream toward the collision point 490. At collision point 490, the streams of coating material and carrier gas collide, atomizing and vaporizing the coating material. It is respectfully submitted that this structure is different from the co-axial nozzle according to the present invention, where the carrier gas advances along a straight path and the carrier gas and CVD-material do not collide. Note especially claims 13 and 14. It is respectfully submitted that such atomizer as in Lyons, et al., would have neither disclosed nor would have suggested the structure according to the present invention, including the co-axial nozzle with the central and outside nozzles, and wherein the central nozzle protrudes with a length 0.2-1.0 mm beyond the end of the outside nozzle opening into the vaporization chamber.

Benzing, et al. discloses conversion of liquid phase materials into vapor phase materials in a cyclone evaporator for use in a variety of applications. In one embodiment, there is described an evaporator in a CVD system that utilizes a carrier gas and precursor. The evaporator includes a body, a chamber disposed in the body,

an atomizer assembly having a carrier gas inlet and a liquid precursor inlet, and further having an opening into the chamber, and a vapor outlet extending to the body from the chamber. See column 2, lines 28-34. Note also column 2, columns 35-45; column 3, lines 20-24; column 4, lines 3-8; column 5, lines 40-42, 63 and 64; column 6, lines 11-15; and column 7, lines 45-57.

It is respectfully submitted that Benzing, et al. would have neither taught nor would have suggested such apparatus in the present claims, including wherein the central nozzle protrudes at a specified length beyond the end of the outside nozzle opening, and advantages thereof, among other features of the present invention.

Note that the rejection over Benzing, et al. by itself did not include a rejection of claim 7, the subject matter of which has been incorporated into claim 1. Clearly the rejection using the teachings of Benzing, et al. by itself is moot.

Li, et al. discloses a modular liquid vaporizing apparatus, described most generally at column 4, lines 4-16. See also column 4, lines 17-22. Note also column 5, lines 46-56, and column 6, lines 4-13.

Note that on page 5 of the Office Action mailed December 16, 2004, the Examiner has not rejected claim 7 over the teachings of Li, et al., which subject matter of claim 7 has been incorporated into claim 1. For this reason alone, it is respectfully submitted that the rejection over the teachings over Li, et al. is improper in connection with the presently amended claims.

In any event, it is respectfully submitted that Li, et al. would have neither disclosed nor would have suggested such vaporizer as in the present claims, including

the co-axial nozzle having the taper of the outside diameter, and wherein the central nozzle extends toward the vaporization chamber with a length 0.2-1.0 mm beyond the end of the outside nozzle opening into the vaporization chamber, and advantages thereof, as discussed in the foregoing.

Additionally, note that according to the present invention a cooling means is provided for cooling the CVD material feed portion. Li, et al. discloses a stepped cooling jacket 26",which surrounds the elongated portion of the vaporizer apparatus housing, with cooling liquid being fed into the cooling jacket and out of the cooling outlet (see Fig. 5A of Li, et al.). It is respectfully submitted that, in addition, Li, et al. would have neither taught nor would have suggested the cooling means as in the present apparatus, with the co-axial nozzle having functions and structure as set forth in the present claims.

Onabe discloses a liquid raw ingredient feeding device for CVD, including a cylindrical and distally tapered atomizing gas feeding unit, configured to surround the outer circumference of the feeding unit and which feeds an atomizing gas for atomizing the liquid raw ingredient into a gap between itself and the aforementioned raw ingredient solution feeding unit. Note, in particular, paragraph [0012] of the English translation of Onabe. Note also paragraph [0015] of this English translation, showing that the feeding device has a threefold structure constituted approximately by (1)the cylindrical raw ingredient solution feeding unit, (2) the cylindrical and distally tapered atomizing gas feeding unit, configured to surround the outer circumference of the feeding unit, and (3) the cylindrical shield gas feeding unit which is configured to

surround the outer circumference of the atomizing gas feeding unit with the exception of the distal end thereof.

Note that Onabe has a relatively complex structure for atomizing. It is respectfully submitted that this structure does not teach, nor would have suggested, the relatively simple structure of the co-axial nozzle according to the present invention, including the protruding of the central nozzle to the specified length as in the present claims; especially with the taper of the outside diameter of the nozzle (note that according to the present invention as can be seen, for example, in Figs. 5(1)-(4), the inner diameter of the structure forming the outside nozzle is not tapered; see, especially, claims 13 and 14).

Furthermore, in connection with each of the previously discussed references, it is respectfully submitted that these references would neither taught nor would have suggested the degree of tapering of the tapering portion, as set forth, for example, in claim 2; and/or the structure of the tapering portion as in claims 3-4.

It is respectfully submitted that the additional teachings of Toyoda, et al., together with the teachings of Benzing; or the additional teachings of Toyoda, et al. or Benzing, together with the teachings of Onabe, would have neither have disclosed nor have suggested the presently claimed invention.

Toyoda, et al., discloses a CVD apparatus for Cu formation, using as a raw material a mixture of a liquid material containing copper hexafluoroacetylacetonate and adducted molecules; or a solid material containing this copper-containing material, adducted molecules and a solvent. This patent discloses that the surface of a member

where the raw material exists is provided with a fluorinated organic polymer combined, a fluorinated metal, an insulator or a Ti compound. See column 2, lines 53-57 and 62-66. Note also column 3, lines 27-30; and the paragraph bridging columns 4 and 5.

Noting that the subject matter of claim 7 has been incorporated into claim 1, and claim 7 has not been rejected over the teachings of Benzing, et al. (either alone or together with Toyoda, et al.), clearly the rejection over the combined teachings of Benzing, et al. and Toyoda, et al. is moot.

In any event, even assuming, arguendo, that the teachings of Toyoda, et al. were properly combinable with the teachings of Benzing, et al.; or that the teachings of Toyoda, et al. or Benzing, et al. were properly combinable with the teachings of Onabe, the combined teachings of these references would have neither disclosed nor have suggested the presently claimed invention, including the nozzle structure according to the present invention, which is a co-axial nozzle wherein the outside diameter of the nozzle tapers towards it outlet, and wherein the central nozzle protrudes with a specified distance beyond the end of the outside nozzle opening, and advantages thereof; or the other aspects of the present invention as discussed previously (including (cylindrical) tubes forming the central and outside nozzles), and advantages thereof.

In view of the foregoing comments and amendments, reconsideration and allowance of all claims presently in the application are respectfully requested.

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paper, including extension of time fees, to the Deposit Account No. 01-2135 (Case No. 396.43773X00), and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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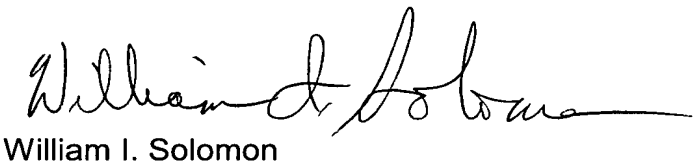

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